Far offshore wind farms are more exposed and harder to access than inshore wind farms.

Deeper water increases the over-turning moment on wind turbine foundations. The environmental conditions at far offshore sites are very challenging with high waves and strong winds; which both increase the loads and make the foundations harder to install. Jacket structures may be more suitable for these conditions, but there is little research on the effects of wave loading on jacket type wind turbine substructures in deep or intermediate depth water.

Scale model testing combined with numerical modelling can aid understanding of wave loading

1/60th scale models of generic monopile and jacket type wind turbine substructures were built and tested in a wave tank. The tests were designed to simulate real ocean conditions including rogue waves and 50 year storm waves. The occurrence and development of rogue waves were also studied, as they may cause particular problems for wind turbines. Wind turbines are usually shut down in extreme storms, but rogue waves may cause unexpectedly high wave loads when the turbine is operating.

Scale model test results have been used to validate numerical models

The experimental work links to CFD model development at Manchester Metropolitan University. A SWAN (Shallow WAves Nearshore) model has also been developed to predict the effect of the substructures on wave development across the SUPERGEN exemplar wind farm.

Jacket type substructures offer advantages over monopiles, but detailed tests are required

Test results show that monopile type designs will experience higher wave loads, more run-up and increased deck slam volume compared to the equivalent jacket structure. The loads on a jacket structure vary by as much as 40% with the wave direction. Steep and breaking waves, combined with a complex structure mean that it is very hard to predict these variations accurately without detailed scale model tests.